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MICHIGAN DEPARTMENT OF NATURAL RESOURCES

Fisheries Division

GREAT LAKES COHO SALMON MORTALITIES 1972-1973

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SUMMARY

The early life of the Great Lakes coho salmon in the hatcheries is accompanied by relatively high levels of mortalities from incubation through approximately the first six weeks of feeding.

Fish from parents of lakes Michigan and Erie show similar, very typical, behavioral symptoms before death which are absent in fish from Lake Superior parents. During this stage of their life cycle (after absorption of the yolk sac) the mortalities are highest in fish from Lake Michigan parents, but virtually nonexistent in fish from Lake Superior parents. Attempts to isolate pathogens during these mortalities have been unsuccessful. Losses at different stages, from incubation through two month old fingerlings, show considerable variation from state to state and hatchery to hatchery.

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Harry Westers, Fisheries Biologist

INTRODUCTION

Relatively high mortalities have been experienced during the early hatchery life of the Great Lakes coho salmon.

The cause of these mortalities has never been positively determined although investigations into this problem were made by a number of laboratories and individuals (Westers, 1972 - Michigan Coho Salmon Mortalties 1971-72 - unpublished).

Since no definite answers were found, it was decided to approach the problem by means of a cooperative effort involving those Great Lakes states engaged in a coho salmon program. A questionnaire was prepared and distributed to the participating states for their input. The following states returned the requested information.

1. Pennsylvania - Pennsylvania Fish Commission

    A. Source of eggs:

        (1) Lake Erie - Walnut Creek
        (2) Lake Michigan - Little Manistee River

    B. Hatcheries involved:

        (1) Linesville Fish Cultural Station
        (2) Tionesta Hatchery
        (3) Corry Hatchery
        (4) Walnut Creek Hatchery

2. Pennsylvania - Marine Protein Corporation

    A. Source of eggs:

        (1) Lake Erie

    B. Hatcheries involved:

        (1) Spring Bank Hatchery
        (2) Mammoth Spring Hatchery (Arkansas)

3. Ohio - Division of Wildlife

   A. Source of eggs:

      (1) Lake Michigan - Platte River

   B. Hatcheries involved:

      (1) Lake Erie Hatchery

4. New York - Department of Environmental Conservation

   A. Source of eggs:

      (1) Lake Michigan - Platte River

   B. Hatcheries involved:

      (1) Caledonia Hatchery

5. Minnesota - Department of Natural Resources

   A. Source of eggs:

      (1) Lake Superior - French River

   B. Hatcheries involved:

      (1) French River Hatchery
      (2) St. Paul Hatchery
      (3) Lanesboro Hatchery
      (4) Platte River Hatchery (Michigan)

6. Michigan - Department of Natural Resources

   A. Source of eggs:

      (1) Lake Michigan - Platte River
      (2) Lake Michigan - Little Manistee River
      (3) Lake Michigan - Thompson Creek

   B. Hatcheries involved:

      (1) Platte River Hatchery
      (2) Thompson Hatchery
      (3) Grayling Fish Disease Unit

Appreciation is expressed for the response received from the above listed states, agencies and individual hatcheries. Inasmuch as we are going to collect coho salmon eggs from the first full cycle second freshwater generation in the

fall of 1973, it will be important to continue this joint effort of information gathering. A new questionnaire has been prepared and is enclosed with this report (Appendix). Continued cooperation is considered valuable and will be appreciated.

RETURNING ADULTS

Coho salmon adults were captured for spawning from lakes Superior, Michigan and Erie.

Table I summarizes the data received.

The Platte River run began in late September and continued until mid-November. However, 62 percent of the run occurred from October 6 through 9.

The early fish, of which over 20,000 were permitted to pass the lower weir for upstream migration to the egg take facility, did not (immediately) continue their upstream movement. An emergency egg take operation was, therefore, conducted at the lower weir where fish were collected by means of electric boom shockers.

There was, what appears to be, a significant difference between the sizes of the early September run fish and the November migrants.

EGG TAKE OPERATION

Table II summarizes the data on egg take operations.

Three basic egg take techniques were used:

1. Handstripping of live fish - conventional technique as used for trout. Minnesota applied it.

2. The surgical method for the females with handstripping of the males. (Michigan and Pennsylvania)

3. Air (using pure oxygen) spawning under pressure of four pounds per square inch (Michigan).

Difficulty with the third technique was experienced at the Little Manistee Station but at Thompson it worked rather well. Apparently it is important to have the fish at prime ripeness, ready to spawn, as was the case at Thompson.

Coho salmon seem to ripen less uniform than the chinook salmon. At Thompson, however, the coho salmon moved in en masse quite suddenly and in very ripe condition. This is a somewhat unusual occurrence, and probably contributed to higher egg quality.

At the Little Manistee the salmon were kept in holding ponds until 20 percent were ripe. All the fish in the pond were then channeled through the spawn taking facility. Possibly many eggs were taken before their optimum condition of ripeness. This seems to be reflected in the relatively high number of rejects (Table II).

It is not known why the Thompson Creek salmon came up suddenly ready to spawn, or why these fish remained lake bound until they had reached that condition. At the Platte River, the September run of very silvery fish of small size caused confusion to the spawn take operation. The decision was made to shift the operation to the lower weir where the fish were physically removed from the river and transported to the spawn taking facility. Eggs so taken had a 42.2 percent average eye-up versus a 58.3 percent average of the eggs collected from those salmon who had moved up to the upper weir. Those fish that were used from October 27 thru November 3 gave eggs with an average eye-up of 66 percent. These were probably the eggs from the fish that ran the river from October 6-9 (62 percent of the total run).

This indicated that there was a "pre-run" and a "post-run" apart from the main run. Both the pre-run and the post-run produced inferior quality eggs.

Minnesota reports that their cohos were reluctant to move up-river as the water temperature decreased. A large share of their fish had to be seined

from the pool at the river mouth and were taken into the hatchery. There they were sorted and the green fish were kept in tanks to ripen. Only when sufficient numbers were ripe the fish were spawned.

The fish were live stripped, the conventional method used for trout.

EGG INCUBATION

The Platte River eggs were incubated at the new Platte River Hatchery in Heath incubators. Eye-up improved over last year. It ranged from 30 percent to 70 percent, but averaged 53 percent. Relatively poor results were obtained with eggs taken at the harvest weir (39, 46, 44 and 40 percent eye-up).

Ohio received green eggs on November 13 and 21. Eye-up was 27 and 37 percent respectively. New York State received green eggs on November 14. Eye-up was 43 percent. Incubation temperatures ranged from 47°F (Platte River and New York) to 53°F (Ohio). Michigan and New York used the Heath incubator, Ohio the trough type. Numbers of eggs incubated per gallon per minute flow was approximately equal (±30,000 eggs/gpm). Other Lake Michigan coho eggs were taken at the Little Manistee. Eggs were transported to the Platte River Hatchery and to Pennsylvania. Eye-up at the Platte (4 lots) ranged from 37.5 to 73.2 percent, the eye-up in Pennsylvania (1 lot of 224,000 eggs) was 72 percent. Pennsylvania incubated in jars at 50°F well water. Heavy iron deposits built up and were rinsed off after 31 days of incubation. Dissolved oxygen was 7.2 ppm.

A third source of Lake Michigan coho eggs was from the Thompson Creek run. These are offspring of an Alaskan strain. Eggs were incubated in 45°F in trough incubators. Eye-up ranged from a low of 48 percent (the first lot of 29,000 eggs) to a high of 86 percent (372,000 eggs). The average eye-up success was around 70 percent.

Pennsylvania collected the Lake Erie coho eggs from the run in Walnut Creek.

At the Linesville Hatchery 81,200 eggs taken on November 8 were incubated in 50°F. Eye-up was 59.25 percent. Eyed eggs were transferred to a 700 gallon tank.

At the Tionesta Hatchery three lots of Lake Erie eggs were followed through.

Lot #1 contained 171,000 eggs, and were incubated in filtered water (to remove iron) at 47.7°F. Eye-up was about 70 percent.

Lot #2 contained 90,000 eggs. These were also incubated on filtered water at 47°F. Eye-up was 78 percent.

Lot #3 contained 12,000 eggs. These were incubated on unfiltered water at a temperature of 56.5°F. Eye-up was 58 percent. Just before hatching about 1½ inch of iron deposit was removed from the eggs.

At the Corry Hatchery three lots of Lake Erie eggs were incubated in 49°F. The average eye-up was 69 percent.

A lot of over 200,000 Lake Erie eggs, taken on November 16, was incubated at the Spring Bank Hatchery in a 55 gallon drum at a constant temperature of 49°F. Flow was 7 gpm. Eye-up was not determined, but as eyed eggs they were shipped to Mammoth Spring Hatchery in Arkansas. Incubation continued in Heath incubators (2 and 3 quarts per tray) at 60°F. The average loss of eggs was 52 percent. There was no difference in loww between 2 or 3 quarts of eggs per tray.

Lake Superior coho eggs were taken from the French River in Minnesota. About one million were incubated at the French River Hatchery in trough incubators at a temperature that ranged from 42°F down to 33°F. Most of the time the temperature was from 35°F to 39°F. Eye-up was 26 percent.

Eggs placed at the St. Paul Hatchery were incubated at a constant temperature of 52°F in Heath incubators.

Eye-up was 46 percent. Eyed eggs were sent to the Lanesboro Hatchery for hatching and rearing.

Two lots of green eggs received at the Lanesboro Hatchery were incubated in Heath incubators at a temperature of 48°F. Eye-up was 33 and 36 percent.

FRY AND FINGERLING REARING

The eyed eggs hatched with the following results:

Lake Michigan Coho

Platte River Hatchery	- 97 percent
Pennsylvania	- 90 percent
Ohio	- 45 percent
New York	- 79.5 percent
Thompson Hatchery (Alaskan Strain)	- 90 percent

Lake Erie Coho

Linesville Hatchery	- 87.5 and 76.5 percent (iron deposit)
Corry Hatchery lot #1	- 98 percent
Corry Hatchery lot #2	- 95 percent
Corry Hatchery lot #3	- 95 percent
Tionesta Hatchery lot #1	- 95 percent
Tionesta Hatchery lot #2	- 90 percent
Tionesta Hatchery lot #3	- 1.3 percent (iron deposit)
Spring Bank Hatchery	- unknown
Mammoth Spring	- unknown

Lake Superior Coho

Lanesboro Hatchery lot #1	- 30.57 percent
Lanesboro Hatchery lot #2	- 33.37 percent
Lanesboro Hatchery lot #3	- 30.17 percent

Pennsylvania made the following observations. The Lake Michigan coho eggs (Little Manistee) incubated in 50°F water, hatched 76.55 percent of the eyed eggs. It was noticed that of the 23.45 percent loss about half the fry emerged partly, with the head out of the shell. This same phenomenon was

observed with the Lake Erie coho to the same degree at the same hatchery (Linesville). Other hatcheries did not report this problem except for the Tionesta Hatchery, where it was reported of two of the three lots but only to a very minor extent (one percent or less). Pennsylvania (Linesville) apparently notified these units (Tionesta and Corry) about this peculiarity. It appears that this problem was peculiar to Linesville, unless such a phenomenon went unnoticed by the other states.

The sac fry mortalities were as follows:

Lake Michigan Coho

Platte River Hatchery	- 2 percent
Pennsylvania	- 2 percent
Ohio	- unknown
New York	- 45.5 percent up to feeding
Thompson Hatchery (Alaskan Strain)	- 48 percent up to 500/lb.

Lake Erie Coho

Linesville Hatchery	- 16 percent - (iron)
Corry Hatchery lot #1	- 3 percent
Corry Hatchery lot #2	- 2 percent
Corry Hatchery lot #3	- 5 percent
Tionesta Hatchery lot #1	- 7 percent
Tionesta Hatchery lot #2	- 2 percent
Tionesta Hatchery lot #3	- 15 percent
Spring Bank Hatchery	- unknown
Mammoth Hatchery	- 13 percent - (60^{o}F)

Lake Superior Coho

Lanesboro Hatchery lot #1	- 26 percent
Lanesboro Hatchery lot #2	- 26 percent
Lanesboro Hatchery lot #3	- 63 percent
Platte River Hatchery	- 1 percent

Percent mortalities during yolk sac absorption, swim-up and early feeding:

Lake Michigan Coho

Platte River Hatchery	- 34 percent
Pennsylvania	- 38 percent

Ohio	- 71.7 percent hatch to end of die-off
New York State	- 23.7 percent
Thompson Hatchery (Alaskan Strain)	- 48 percent

Lake Erie Coho

Linesville Hatchery	- 25 percent and continuing (Feb. 2) at the rate of 1.5 to 2.0 percent daily
Corry Hatchery lot #1	- 3 percent
Corry Hatchery lot #2	- 18 percent
Corry Hatchery lot #3	- 20 percent
Tionesta Hatchery lot #1	- 15 percent
Tionesta Hatchery lot #2	- 22 percent
Tionesta Hatchery lot #3	- 24 percent
Spring Bank Hatchery	- 20 percent
Mammoth Hatchery	- 47.5 percent

Lake Superior Coho

Lanesboro Hatchery lot #1	- 1.4 percent
Lanesboro Hatchery lot #2	- 1.5 percent
Lanesboro Hatchery lot #3	- 3.1 percent
Platte River Hatchery	- 8 percent

The behavior of the sick fish was typical of what had been observed in other years. The "syndrome" occurred both in the Lake Michigan and Lake Erie salmon, but was not seen in the Lake Superior salmon.

The syndrome involved one or more of the following symptoms: slow spiraling, darkening of color, emaciated condition (pin-heads), loss of equilibrium and direction, erratic spurts, weak condition (lethargic), periodic "rest" stages on the bottom, floating at the surface. The most noticeable condition was large numbers of fish near the foot of the raceway (Platte River Hatchery) slowly whirling in corkscrewing patterns just before they died.

All hatcheries which reared Lake Michigan and Lake Erie coho salmon fingerlings observed the described symptoms during yolk-absorption, swim-up and the first weeks of feeding.

Minnesota reported no such symptoms present in the Lake Superior coho. However, heavy mortalities did occur in the sac-fry and yolk absorption stages, but these were apparently caused by gill disease, blue sac and deformities.

Minnesota transferred 160,000 eyed eggs to Michigan (Platte River) primarily to compare them with those at the Platte River Hatchery as well as with those reared in Minnesota. Fifteen thousand fry were lost during the period of April 6 to May 21 from hatch-off to feeding fingerlings (1000/lb.). This nine percent mortality occurred primarily during the first 18 days of feeding. During this period, nor at any other time, were the typical symptoms of the Lake Michigan/Erie coho observed in these fish.

DISCUSSION

The quality of the eggs showed considerable variation. The data indicates that transporting green eggs reduces the eye-up success. One striking exception to this is the lot of eggs transported from the Little Manistee in Michigan, to Pennsylvania (72 percent eye-up). Eye-up also seems to be negatively affected when fish are physically removed from their lake or stream environment and transported to another location for spawning (Platte River and Minnesota). This could be the cause for the low eye-up levels of the Lake Superior coho eggs in Minnesota. However, the temperatures during incubation were also very low in Minnesota (average of 35°F to 39°F). This also could have been a (or the) factor.

In Pennsylvania some eggs were incubated at a temperature of 56.5°F. An eye-up of 58 percent resulted versus 70 and 78 percent for the same eggs incubated at temperatures of 47.7°F respectively. However, the eggs incubated under conditions of the highest temperature were also receiving unfiltered water versus filtered water for the other two lots. Iron deposits of up to 1.5 inches thick accumulated on the eggs in unfiltered water. Yet this may not have affected the eye-up since at the Linesville Hatchery eggs were permitted to incubate in water which caused heavy iron deposits without any apparent detrimental affects to eye-up. However, hatching appears to be affected by the iron. The phenomenon

at Linesville of partially hatched eggs and the high percentage of egg loss just before hatching may have been caused by the iron.

Percentages of eyed eggs actually hatching were relatively low when iron was present:

Linesville Hatchery -- 87.5 and 76.5 percent (versus 90 to 98 percent).

Tionesta Hatchery lot #3 -- 1.3 percent (versus 90 and 95 percent).

Fry mortalities were encountered at all hatcheries.

Sac-fry mortalities, generally, were less than six percent for the Lake Michigan and Lake Erie coho, but were very high in the Lake Superior coho hatched in Minnesota (26, 26 and 63 percent) yet very low for the Lake Superior coho hatched in Michigan (one percent). Eyed eggs of all the Lake Superior coho were incubated at temperatures of 48°F in Minnesota and between 44°F and 50°F in Michigan.

Why the high sac fry losses in the Minnesota Hatchery and virtually none in Michigan is unknown.

In Minnesota the eyed eggs were treated with NaCl twice a week.

Fingerling mortalities were considerably higher than those of the sac fry. As the fish absorbed the yolk sac and transformed into the swim-up stage, mortalities started to increase with time and development. It was during this transition period that the "syndrome" was observed in the coho which originated in lakes Michigan and Erie, but not in the Lake Superior fish. The mortalities continued into the feeding period with fish that apparently never started to feed. At the Grayling Fish Disease Unit of the Michigan Department of Natural Resources, detailed investigations were made relative to the possible involvement of infectious diseases. Infectivity experiments, followed by routine diagnostic techniques for bacterial and viral infections, failed to demonstrate the presence

or involvement of any of the known fish pathogens. The investigations into the coho fry mortalities have not to date shown any indication of infectious diseases as a primary factor. The losses of the Lake Michigan coho attributable to the typical syndrome were higher than the Lake Erie coho.

DDT and PCB levels in Lake Michigan fish are also higher than those of Lake Erie.

FINAL COMMENTS

1. Egg quality of the freshwater coho salmon is poorer than the Pacific salmon.

2. Most likely egg quality is negatively affected when they are transported green, when adults are excessively handled (transported) before spawning and when spawn taking occurs before optimum ripeness has occurred.

3. Pennsylvania transported green eggs very successfully and their method should be described.

4. Incubation temperatures appear to be optimum from 47°F to 52°F. Temperatures of less than 40°F and over 55°F may be quite detrimental.

5. Iron precipitates to not seem to affect the eye-up result (early embryonic development) but may interfere seriously with successful hatching.

6. Sac fry losses are generally low, but very high in Lake Superior fish hatched in Minnesota's Lanesboro Hatchery. Eyed eggs shipped to Michigan were hatched in the Platte River Hatchery. Sac fry of this lot did not undergo a significant mortality. The cause of the high losses experienced in Minnesota should be further investigated. Gill disease, blue sac and deformities were reportedly present.

7. The "typical syndrome" was observed in Lake Michigan and Lake Erie coho, not in the Lake Superior coho.

8. Infectious diseases were absent.

9. Losses during the transition period (absorption through swim-up) were considerably higher in Lake Michigan coho than in the Lake Erie coho, but very low in the Lake Superior coho.

10. Levels of DDT and PCB's in Lake Michigan fish are higher than those of Lake Erie fish.

11. I hypothesize that pesticides, PCB's and possibly other toxicants are responsible for those mortalities observed during the yolk sac absorption which are accompanied by one or more of the typical symptoms.

12. I am furthermore of the opinion that a definite percentage of these fish are destined to die due to levels that are lethal for them. Others, that approach this threshold will die when minor stresses are applied (environmental, fish cultural practices) and will then also exhibit the typical symptoms. The degree of stress affects the level of mortalities caused by the toxicants in the fish.

13. The high incidence of visible goiter in Lake Superior adults (50 percent), indicative of a possible serious iodine deficiency, might manifest itself in poorer quality eggs.

APPENDIX

Great Lakes Coho Salmon Records

I. Returning Adults

- A. Fishing Success
  - 1. Estimated Percent Return
- B. Condition
  - 1. Average Weight - Length
  - 2. Lamprey Scars
  - 3. Tumors/Growths
  - 4. Diseases
- C. Spawning Run
  - 1. Daily River Water Temperature
  - 2. Daily Air Temperature
  - 3. Condition of Fish
  - 4. Behavior of Fish

II. Egg Take Operation

- A. Daily Water Temperature
- B. Technique Used
- C. Number of Eggs/Female
- D. Egg Quality
  - 1. Rejects (Reasons)
  - 2. Size (No./oz.)
  - 3. Color

III. Egg Incubation

A. Type Incubator

B. GPM Flow per Number of Eggs

C. D.O. Readings

D. Daily Temperature or High and Low and Average

E. Expected Eye-up

F. Actual Eye-up in Percent of Green Eggs

G. Other Information

IV. Fry and Fingerlings

A. Hatch-Off (Percent of Eyed Eggs)

B. Sac Fry

1. Losses (Percent of Sac Fry)

2. Daily Temperature

C. Swim-Up Fry

1. Losses During Yolk-sac Absorption (Percent of Fry)

2. Symptoms During Losses

3. Daily Temperature

D. Feeding Fry/Fingerlings

1. Percent Losses

2. Symptoms During Losses

3. Daily Temperature

4. D.O.

5. Termination of Losses

V. Any Additional Comments

HW:dp
8/14/73

TABLE I

COHO SALMON ADULTS - 1972 RETURNS

	Lake Superior French River	Lake Michigan Little Manistee	Lake Michigan Platte River	Lake Michigan Thompson Creek	Lake Erie Walnut Creek
State	Minnesota	Michigan	Michigan	Michigan	Pennsylvania
Percent Anglers	2%	---	---	---	---
Returns Weir	3%	2.3%	5.9%	11.2%	2.5%
Average Weight	3.21 lbs.	6.5 lbs.	5.1 lbs.-Sept.	7.6 lbs.	6.6 lbs.
Average Length	21.5"	26.3"	23.8" Sept. 27.4" Nov.	26.6"	24.0%
Percent Lamprey Scars	---	0.4%	0.0	---	13.3%
Tumors (Goiter)	50% observable gill tumors	---	<0.01% observed	---	17.3%
Diseases	none observed but heavy parasite load (spiny headed worms)	none	0.0013° K.D. gross symptoms 3.7% lab. test	---	no symptoms observed
Water Temp.	Ave. Sept. 50.5° Oct. 38.5° Nov. 36.0° Hi-56 Low 33	---	---	---	Hi-53° Low 39° Average 43°
Condition of Fish	Good	Good	Good	Good	---
Behavior	Reluctant to move at low temp.	Normal	Reluctant to Move	Normal	---
Jacks	0.045%	---	---	---	.6%

TABLE II

EGG TAKE OPERATION - COHO SALMON - 1972

	Lake Superior French River	Lake Michigan Little Manistee	Lake Michigan Platte River	Lake Michigan Thompson Creek	Lake Erie Walnut Creek
State	Minnesota	Michigan	Michigan	Michigan	Pennsylvania
Water Temperature	---	---	---	---	43° - 53°
Technique	Live Stripping	Air (O_2) Pressure + Surgical	Surgical	Air (O_2) Pressure	Surgical
Male-Female Ratio for Fertilization	2M/F Hand Stripping	Australian and 2M/F Hand	2M/F Hand Stripping	---	2M/F Hand Stripping
Number Eggs per Female	2351	2069-2444	2780	---	---
Size of Eggs	232/oz.	---	---	---	---
Color of Eggs	Pale Yellow to Scarlet Red	Pale Yellow	Pale Yellow	Pale Yellow	Light Pink (Typical Coho)
Condition of Eggs	Normal	Normal	Normal 12.8% Reject	---	Normal 15% Rejects
Sperm Quality	---	---	---	---	49° - Maximum 3 min. viability